(NASA-TM-80001) OAST SPACE THEME WORKSHOP. VOLUME 1: SUMMARY REPORT. 1: INTRODUCTION. 2: GENERAL OBSERVATIONS AND SOME KEY FINDINGS. 3: FOLLOW-ON ACTIVITY. QUICK-LOOK COMMENTS AND WORKING PAPERS

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OAST SPACE THEME WORKSHOP

VOLUME I

SUMMARY REPORT

I. INTRODUCTION

II. GENERAL OBSERVATIONS AND SOME KEY FINDINGS

III. FOLLOW-ON ACTIVITY

QUICK-LOOK COMMENTS AND WORKING PAPERS

HELD AT THE
LANGLEY RESEARCH CENTER
APRIL 26-30, 1976

SPONSORED BY NASA-CODE RX

Foreword

The attached material represents the working papers from the OAST Space Theme Workshop held at the Langley Research Center, April 26-30, 1976, and contains a quick-look analysis of the proceedings. The material is unedited and intended for further use by the participants of the workshop and the planning elements of NASA concerned with space mission research and technology. It should be understood that the data do not represent official plans or positions but are part of the process of evolving such plans and positions.

Nearly 100 of the Agency's top technologists and scientists joined with another 35 theme specialists to produce this working document - a document that provides a technical foundation, including research and technology base candidates, for each of the six space themes.

The material in this report is considered essential to the development of Center initiatives in support of these themes. Copies of the report will be made available to the Center Management Board and the individuals at the Centers responsible for the FY'78 program planning cycle. The timing of this planning activity has caused us to distribute this document in this unedited form. Thus, it possibly contains errors, hopefully, more of a typographical rather than a technological nature. Nonetheless, the information contained is of a high professional level, reflecting the efforts of the workshop participants and will be invaluable to the planning and successful execution of the Agency's near- and far-term advanced technology program.

Stanley R. Sadin
OAST Space Theme Workshop
Chairman
NASA Headquarters
Study, Analysis, & Planning Office
Office of Aeronautics and
Space Technology

NASA
OAST SPACE THEMES
WORKSHOP

I. INTRODUCTION

A. Background

OAST is instituting a new approach to the identification of technology initiatives and supporting program requirements. Rather than selecting and advocating new initiatives and programs from among a large number of loosely associated candidates submitted by the Centers, OAST is in the process of developing a technique using Program (Mission) Themes to focus initiative and program requirements. The Space Themes selected by OAST, resulting from the Outlook for Space Study, consideration of National needs and OAST technology goals, and with confirmation from appropriate NASA Program Offices, are:

- o Space Power Station
- o Search for Extraterrestrial Life
- o Industrialization of Space
- o Global Service Station
- o Exploration of the Solar System
- o Advanced Space Transportation System

These Themes were selected as exciting future space opportunities capable of driving technology R&T and acquiring internal and external advocacy support on a program-focused basis. In addition to these Themes, special attention is given to the implications of the Themes on the Research and Technology Base program.

The work of helping to identify these initiatives and their supporting programs has been assigned to newly developed Working Groups (WG)

and Theme Teams (TT) made up of Headquarters and Center representatives covering NASA's major space activities. This representation is noted in Attachments 1 and 2.

B. Workshop Organization and Attendance

To assist OAST in the development of its FY '78 program plan and its candidate technical initiative, and supporting program plans the "Space Theme Workshop," being reported here, was promulgated. Workshop attendance is reported in Attachments 3, 4, and 5; Working Group, Theme Team, and Operations respectively.

The major objective of the Workshop was to develop technology needs, requirements and proposed program plans in support of each Space Theme. In this process, the Workshop identified possible changes and additions to initiatives submitted by the Centers pertinent to the Themes.

In addition, the Working Groups generated candidate disciplinary technology programs that will be used to test OAST's technology goals.

The Workshop was structured to provide maximum interaction of the Space Theme Teams with the Working Groups in order to more fully and meaningfully develop the technology initiatives and programs projected to support the initiatives. The work flow plan is shown in Figure I-1.

C. Report Content

This report, in the interest of providing an early record of the proceedings, presents an unedited, quick overview of the Workshop activity and the working papers of the Workshop TT's and WG's. No attempt was made nor will be made to have the assembled group develop a

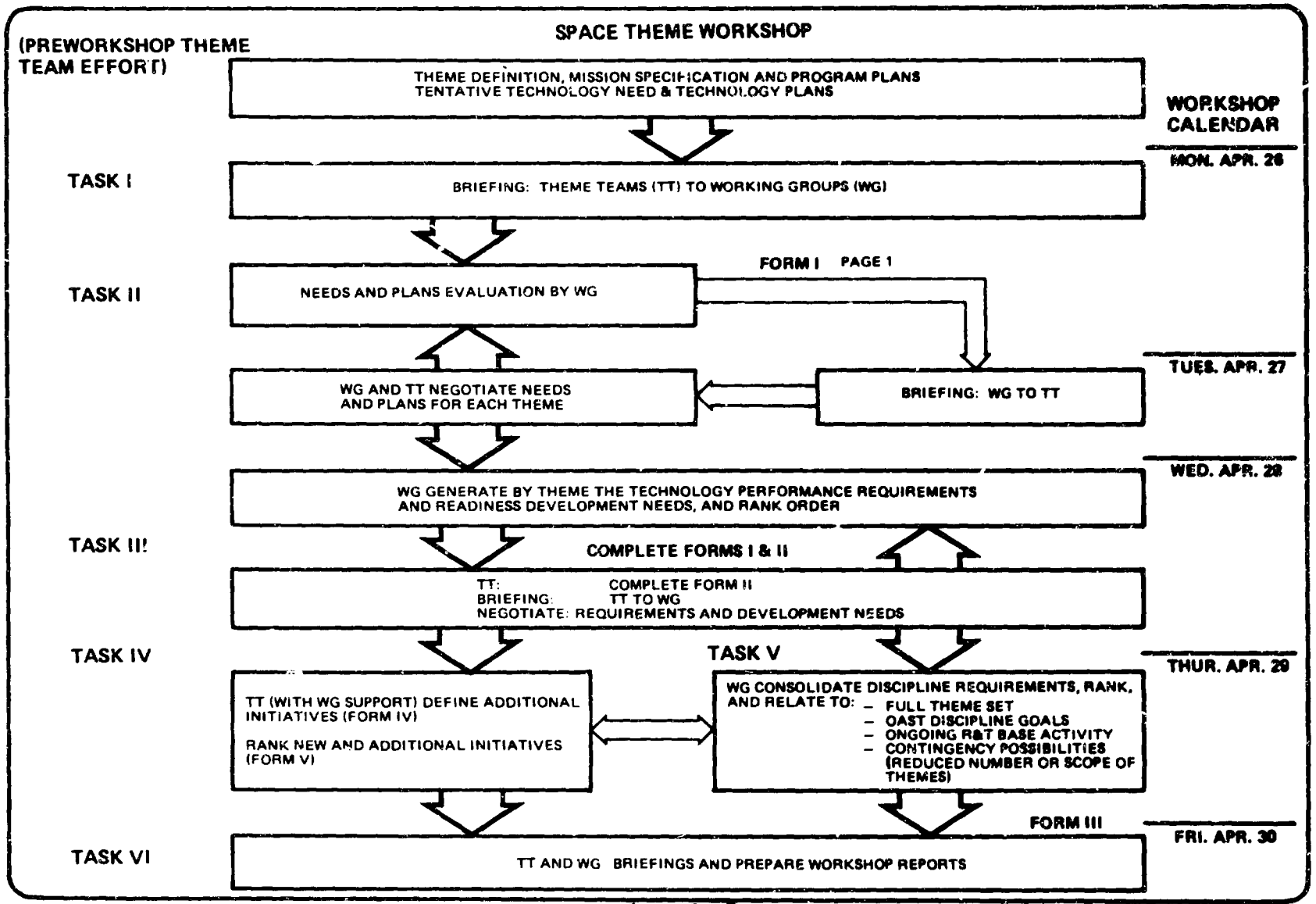

SPACE THEME WORKSHOP
(PREWORKSHOP THEME TEAM EFFORT)
THEME DEFINITION, MISSION SPECIFICATION AND PROGRAM PLANS
TENTATIVE TECHNOLOGY NEED & TECHNOLOGY PLANS
WORKSHOP CALENDAR
MON. APR. 26
TASK I
BRIEFING: THEME TEAMS (TT) TO WORKING GROUPS (WG)
FORM I PAGE 1
TASK II
NEEDS AND PLANS EVALUATION BY WG
TUES. APR. 27
WG AND TT NEGOTIATE NEEDS AND PLANS FOR EACH THEME
BRIEFING: WG TO TT
WED. APR. 28
WG GENERATE BY THEME THE TECHNOLOGY PERFORMANCE REQUIREMENTS AND READINESS DEVELOPMENT NEEDS, AND RANK ORDER
TASK III
COMPLETE FORMS I & II
TT: COMPLETE FORM II
BRIEFING: TT TO WG
NEGOTIATE: REQUIREMENTS AND DEVELOPMENT NEEDS
TASK IV
TASK V
THUR. APR. 29
TT (WITH WG SUPPORT) DEFINE ADDITIONAL INITIATIVES (FORM IV)
RANK NEW AND ADDITIONAL INITIATIVES (FORM V)
WG CONSOLIDATE DISCIPLINE REQUIREMENTS, RANK, AND RELATE TO:
– FULL THEME SET
– OAST DISCIPLINE GOALS
– ONGOING R&T BASE ACTIVITY
– CONTINGENCY POSSIBILITIES (REDUCED NUMBER OR SCOPE OF THEMES)
FORM III
FRI. APR. 30
TASK VI
TT AND WG BRIEFINGS AND PREPARE WORKSHOP REPORTS

FIGURE I-1

consensus position on the complex matters considered. Rather, the material is intended to provide basic information for further study and comparative analysis with ongoing activity and plans, and to assist in the modification of these plans to enhance NASA's technology program.

This Volume of the "Quick-Look" report contains some general observations and key findings and is identified as Volume I. The following three volumes present summary comments and the working papers of the Theme Teams (Vol. II), the Working Groups (Vol. III), and the R&T Base (Vol. IV).

II. GENERAL OBSERVATIONS AND SOME KEY FINDINGS

Figure 2 presents a summary of a few general observations about the Workshop. The theme concept proved successful in stimulating the working groups to develop extensive list of technology needs which were jointly ranked, from a disciplinary perspective, by both the Theme-Teams and Working Groups through a negotiation process. The Theme Teams, based on the negotiated disciplinary rankings, prepared a technology needs ranking for their respective themes. These theme rankings are presented in their entirety in volume II. Using only the top five technology needs for each theme, a preliminary assessment of theme technology needs. Figures 3, was prepared to identify key supportive technologies among the themes. This list is summarized in Figure 4. A more detailed examination and interaction of the data base developed by the Workshop will be undertaken by OAST in the program selection/budget process.

PRELIMINARY THEME ASSESSMENT OF TECHNOLOGY NEEDS

TECHNOLOGY NEED \ THEME	7 SPACE POWER	8 SPACE INDUST.	9 SET I	10 SOLAR SUP. EXPL.	11 GLOBAL SERVICE	12 ADV. TRANS.
o Autonomous Operations and Systems, Teleoperators, and Software for Autonomous Operations		4		3		4 3
o End-to-End Data Mgt. Systems Hardware and Software			3	4	1	
o Software for Data Analysis			2		2	
o Sensing and Signal Conditioning			1	5	3	
o Attitude Control & Precision Pointing		3			4	
o Large Space Structures (Assembly, Deployment and Control)	2	1	5			
o Advanced Propulsion (High-Pressure Engine, NEP, MPD)		5		1		1
o Advanced Materials for Structures, Cryogenics, Power Generation	5		4		5	2
o Space Power Generation	3	2		2		
o Theory and Experiments on High Voltage Space Plasma Interactions	1					
o Laser Power Transfer	4					5

Figure 3

WORKSHOP OBSERVATIONS

- THEMES PROVED EXTREMELY STIMULATING
- WORKSHOP SHARPENED THEME TECHNOLOGY REQUIREMENTS
- HIGH LEVEL OF INTEREST & SUPPORT OF THEME PROCESS
- MANY ON-THE-SPOT CREATIVE CONCEPTS AND APPROACHES
- IDENTIFIED UNANTICIPATED PROBLEMS AND POSSIBLE SOLUTIONS
- EXCELLENT TRANSFER OF THEME AND TECHNOLOGY UNDERSTANDING
- OUTSTANDING COMPETENCE AND DEDICATION
- GOOD INTERPERSONAL INTERACTIONS
- LITTLE CENTER PAROCHIALISM
- NEAR-TERM NEEDS NOT IN THEMES IDENTIFIED BY WG'S
- OUT-OF-SCOPE PROBLEMS - PREDICTIVE MODELING
  OPERATIONAL SYSTEMS
  LUNAR MATERIALS PROCESSING
  COMPREHENSIVE SENSOR R & T PROGRAM

KEY THEME TECHNOLOGY NEEDS SUMMARY

- o Software for Data Analysis
- o Advanced Propulsion (NEP, MPD, and High Pressure Engines)
- o Space Power Generation
- o Large Space Structures (Assembly, Deployment, and Control)
- o End-to-End Data Management (Hardware and Software)
- o Sensing and Signal Conditioning
- o Autonomous Operations and Systems (Robotics and Teleoperators)
- o Precision Pointing (Non-Inertial)

Figure 4

The Workshop activity closed with presentations by the Workshop Chairman and the OAST Technology Panel Charimen[a]. These presentations covered:

o R&T Base	Attachment -7
o Electronics	Attachment -8
o Materials and Mechanics	Attachment -9
o Power	Attachment -10
o Propulsion	Attachment -11
o Theme Summary	Attachment -12

NOTE: (a) An outline of the "OAST Space Technology Working Group Process" is Attachment 6.

Follow-on Activity

This workshop material will be reviewed and assessed at NASA Headquarters and at the Centers. It will be used to assist in the updating of OAST space technology plans, the modification of previously proposed "New Initiatives," and the generation of totally "New" FY 78 Initiatives.

The present plan is to have the OAST Divisions and Offices request the update of earlier program and initiative submissions. The workshop report and recommendations will be processed through OAST Working Group Panels, Management Board and Steering Committee, and into the program/budget cycle within the Agency--leading to submission to the Administrator in August.

The Theme Teams and OAST Management will complete the workshop technical plans and further develop the Themes and their advocacies. Consideration will be given to establishing task teams to pursue more complex interdisciplinary technology programs.

ATTACHMENT 1

OAST SPACE TECHNOLOGY WORKING GROUPS

MEMBERSHIP AS OF APRIL 30, 1976

CENTERS	NGC E-1	E-2 COMM/DATA HANDLING	SENSORS E-3	SOFTWARE E-4	M-1 MATERIALS	STRUCTURES/ DYNAMICS M-2	M-3 AEROTHERMO/ DYNAMICS	P-1 PROPULSION	POWER P-2
ARC	K.R.Lorell	Dale Lum	Henry Lum	W.P. Jones	H. Nelso H. Larson	---	B. Swenson	---	---
DFRC				(NO MEMBERS APPOINTED)					
GSFC	D.L.Brandel	Ron Muller	J.Eckerman L. Korb	L.Koschmeder	S.Ollendorf C. Vest	Joe Young	---	A. Yetman	F. Ford
JPL	R.Powell T.W.Hamilton W.E.Bachman	R. Powell R.H. Nixon J.C.Springett	D. Morris	W. F. Scott	C. N. Savage	F.VanBiene	B. Dayman	D.Dipprey	L.D.Runkle P. Weiner J. Stearns
JSC	R.C.Kennedy	M. Engert	T.K.Sampson A.E. Potter	J.D.Axelander	R.L.Johnston	B.W.Holder	L.O.Hayman R.C. Ried	C.W.Yodzis	W.Dusenbury
KSC	M.Chambers	T.P.Hershey	H.Williams	F.R.Penovich	R. Arbic	W.E.Clautice	G. Ely	W.Mahorey	W. Chandler
LaRC	W.W.Anderson	W.M.Moore	J.A. Dodgen	E.C.Foudriat	B. Stein	M. F. Card	G.D.Walberg	---	---
LeRC	---	J. Bagwell C. Anzig	H. Mark	---	N.Saunders	R. Johns	---	R. Fink P.Petrash J.Gregory	J.Fordyce/ R.Migra N.Stevens/ J.Morris P. Thollot
MSFC	S.Seltzer	G.Wallace	John Gould	Bobby Hodges	C. Cataldo	C. Lifer	T.Greenwood	K.Chandler	C. Graff
HQ. Chairmen	Wm.Gevarter	H.Alsberg	B. Rubin	C.Pontious	J. Gangler	D. Gilstad	P. Cerreta	F.Stephenson	J. Lazar (Acting)

ATTACHMENT 2

OAST ADVOCACY TEAM MEMBERSHIP SPACE

AS OF APRIL 30, 1976

No.	Theme Title	Hdqtrs (Code)	Center/Other Organizations
7	Multipurpose Space Power Platforms	F. Schwenk (RR) --Leader J. Lazar (RP)	R. Hook - LaRC Plohr - LeRC L. D. Runkle - JPL J. Craig - JSC Charles H. Guttman - MSFC Plotkin - GSFC Billman - ARC
8	Industrialization of Space	G. Deutsch (RW) --Leader J. Gangler (RW)	Kruszewski - LaRC Chambers - ARC Blankenship - LeRC Stearns- JPL McKay - JSC Cataldo - MSFC Fogelson (BuMines) D. Criswell (Lunar Sci. Inst.)
9	Search for Extra-terrestrial Intelligence	S. Sadin (RX) --Leader W. Gilbreath (RX) F. Schwenk (RR) H. Alsberg (RE) I. Rasool (S) R. Young (S) R. Freitag (M) L. Fero (M) F. Bryant (T)	J. Billingham - ARC Edelson - JPL Pieper - GSFC C. Seegar - ARC J. Wolfe - ARC
10	Exploration of the Solar System	A. Henderson (RC) --Leader B. Rubin (RE) F. Stephenson (RP) J. Lundholm (RR) J. Maltz (RW) R. Chase (RX) D. Herman (S)	Friedman - JPL Powell - JPL

OAST ADVOCACY TEAM MEMBERSHIP (CONT.)

No.	Theme	Hdqtrs (Code)	Center/Other Organizations
11	Global Service Systems	C. Pontious (RE) --Leader	Sivo - LeRC
		D. Gilstad (RW)	Hibbs - JPL
		E. Cohn (RP)	(None) - JSC
		W. Gilbreath (RX)	Wallace - MSFC
		McConnell (E)	Peake - GSFC
		Kauffman (S)	Moore - LaRC
			J. Deerwester - ARC
12	Advanced Space Transportation Systems	W. Hayes (RS) --Leader	Swenson - ARC
		P. Herr (RS)	Henry - LaRC
		P. Cerreta (RA)	Thompson - DFRC
		W. Gevarter (RE)	Douglas - LeRC
		F. Stephenson (RP)	Davis - JSC
		J. Gangler (RW)	Spears - MSFC
		R. Chase (RX)	Col. Graetch - SAMSO
		K. Hodge (RO)	Ginn - JPL
		Fero (MT)	Nichols - KSC

SPACE THEME WORKSHOP

ATTACHMENT 3

WORKING GROUP PARTICIPANTS

CENTERS	NGC E-1	E-2 COMM/DATA HANDLING	SENSORS E-3	SOFTWARE E-4	M-1 MATERIALS	STRUCTURES/ DYNAMICS M-2	M-3 AEROTHERMO/ DYNAMICS	P-1 PROPULSION	POWER P-2
ARC	K.R.Lorell	E. VanVleck	J.Vorreiter	---	H. Nelson H. Larson	---	B.Swenson	---	---
GSFC	C.E. Velez	John Sos	J.Eckerman L. King L. Korb	R.desJardins T. Taylor L.Koschmeder	S.Ollendorf	---	---	A.Yetman	F. Ford
JPL	W.E.Bachman J.P.McDaniel D.W.Curkendall C. Ivie	R.H. Nixon G.Garrison	D. Norris	R.V. Morris	C.N. Savage L.Stimpson	M. Trubert F. Van Biene	F.Livingston	E. Pawlik W. Gin	P. Weiner J. Stearns
JSC	R.C.Kennedy	M. Engert	T.K.Sampsel A.E. Potter F. Gibson D. Bogard	J.D.Alexander R. Stokes	L. Leger	B.W. Holder	L.O. Hayman	C.W.Yodzis	
KSC	M.Chambers	---	H. Williams	F.R.Penovich	W.E.Clautice	W.E.Clautice	G. Ely		B. Brown
LaRC	W.Anderson	W.M.Moore	A. Keafer J.A. Dodgen C. Swift	E.Foudriat	W. Slemp R. Swann	E.Naumann	Dr.Walberg	C. Eldred	---
LeRC	---	J. Bagwell G. Anzig	H.Mark	---	N.Saunders	G.T. Smith	---	R. Finke P.Petrash J.Gregory	J. Fordyce N.Stevens/ J.Morris P.Thollot
MSFC	S. Seltzer	G. Wallace	John Gould	Bobby Hodges	C.Cataldo	E.E.Engler C. Lifer	T.Greenwood	K.Chandler	C. Graff
HQ Chairmen	Wm.Gevarter	H.Alsberg D. Serice OTDA	B. Rubin	C.Pontious	B.Achhammer	D. Gilstad	P. Cerreta	P. Herr F.Stephenson	J. Lazar

SPACE THEME WORKSHOP

ATTACHMENT 4

THEME PARTICIPANTS

	MULTI-PURPOSE SPACE POWER #7	SPACE INDUSTRIALIZATION #8	SETI #9	EXPLORATION OF SOLAR SYSTEM #10	GLOBAL SERVICE SYSTEM #11	ADV. SPACE TRANSPORTATION #12	R&T BASE #1
ARC			J.Billingham J. Wolfe C. Seeger				
GSFC					H. Plotkin		
JPL			R. Edelson	R. Powell R.R.McDonald C. Ivie K. Atkins	A. Hibbs		
JSC	J. Craig				P.D. Gerbe	H. Davis	
LaRC	R. Hook	E.Kruszewski			W. Moore	B.Z. Henry J. Decker	T.N.Shoosmith H. D. Orr W. Erickson
MSFC			J. Dozier		G. Wallace	L. Spears	
HQ:	C.Schwenk OAST	J. Gangler, OAST	S.Sadin OAST W.Gilbreath OAST	A.Henderson OAST R. Chase OAST	C.Pontious OAST	B.Hayes OAST	P. Kurzhels OAST
OTHERS:		D. Criswell Lunar Science Institute		D.Herman OSS	H.Ernst OA	L. Fero OSF R. Davis Samso/Aero-Space	

ATTACHMENT S

SPACE THEME WORKSHOP

- OPERATIONS -

S. Sadin	Headquarters
W. Gilbreath	
R. Chase	
C. Tynan	LaRC
G. Boswick	
J. Yates	
A. Dunkley	
B. Maggin	System Consultants, Inc.
W. Cobb	West Virginia Graduate Inst.

ATTACHMENT 6

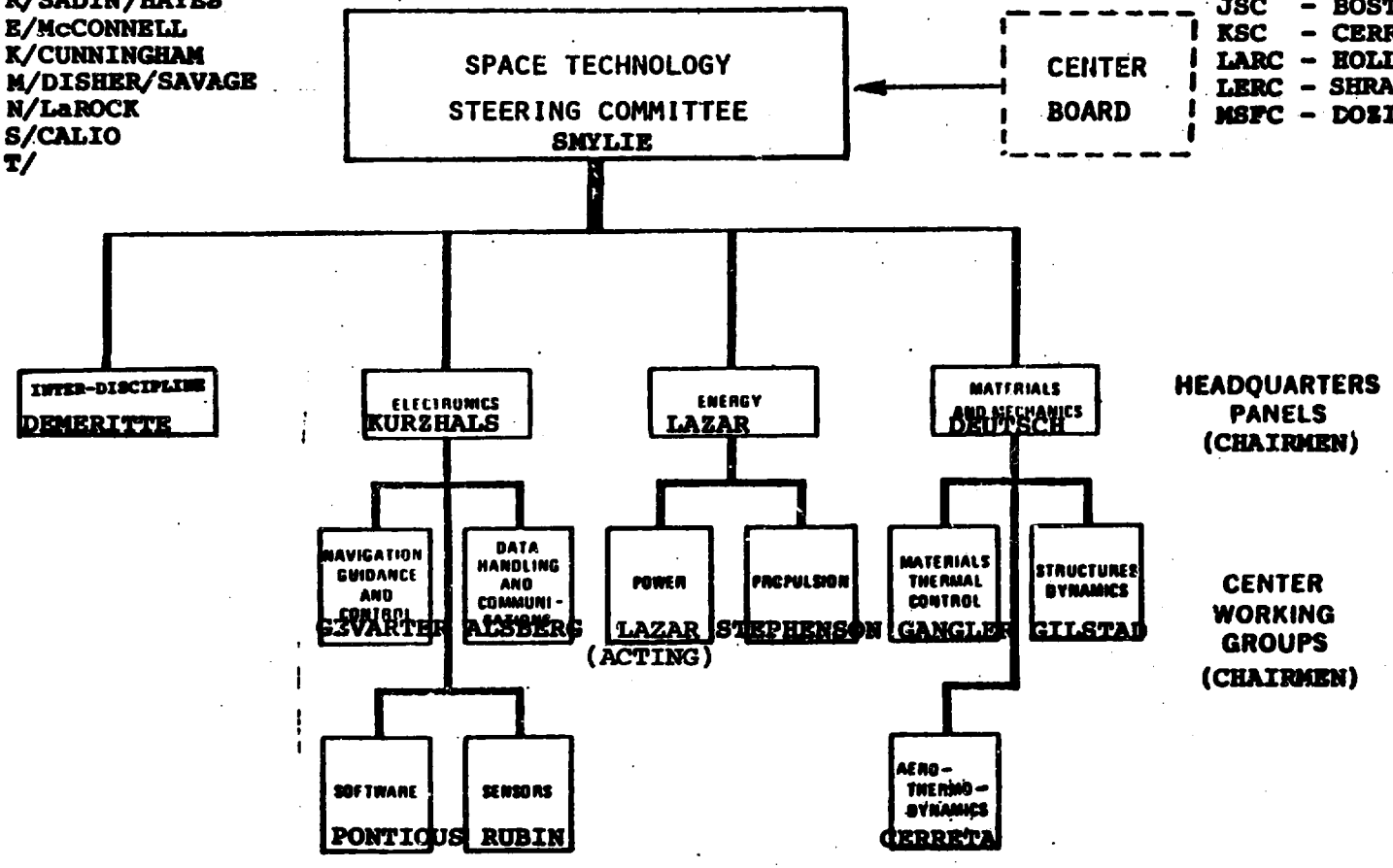
OAST SPACE TECHNOLOGY WORKING GROUP PROCESS

Purpose

OAST is responsible for providing NASA with technology required to accomplish future space objectives. To effectively accomplish this it is essential that R&T activities be planned and coordinated among responsible Headquarters and Field Center organizations. A competent interorganizational process is needed to accomplish this integration and to assess Agency technology. This process is primarily involved with the activities of a set of CENTER WORKING GROUPS. Their general guidance and direction derive from appropriate HEADQUARTERS PANELS and a CENTER MANAGEMENT BOARD. The overall process is reviewed and assessed by the HEADQUARTERS STEERING COMMITTEE.

THE WORKING GROUP PROCESS

R/SADIN/HAYES
E/McCONNELL
K/CUNNINGHAM
M/DISHER/SAVAGE
N/LaROCK
S/CALIO
T/



ARC - CHAPMAN
DRC - THOMPSON
GSFC - JONES
JPL - GODDARD
JSC - BOSTICK
KSC - CERRATO
LARC - HOLLOWAY
LERC - SHRAMO
MSFC - DOZIER

HEADQUARTERS PANELS (CHAIRMEN)

CENTER WORKING GROUPS (CHAIRMEN)

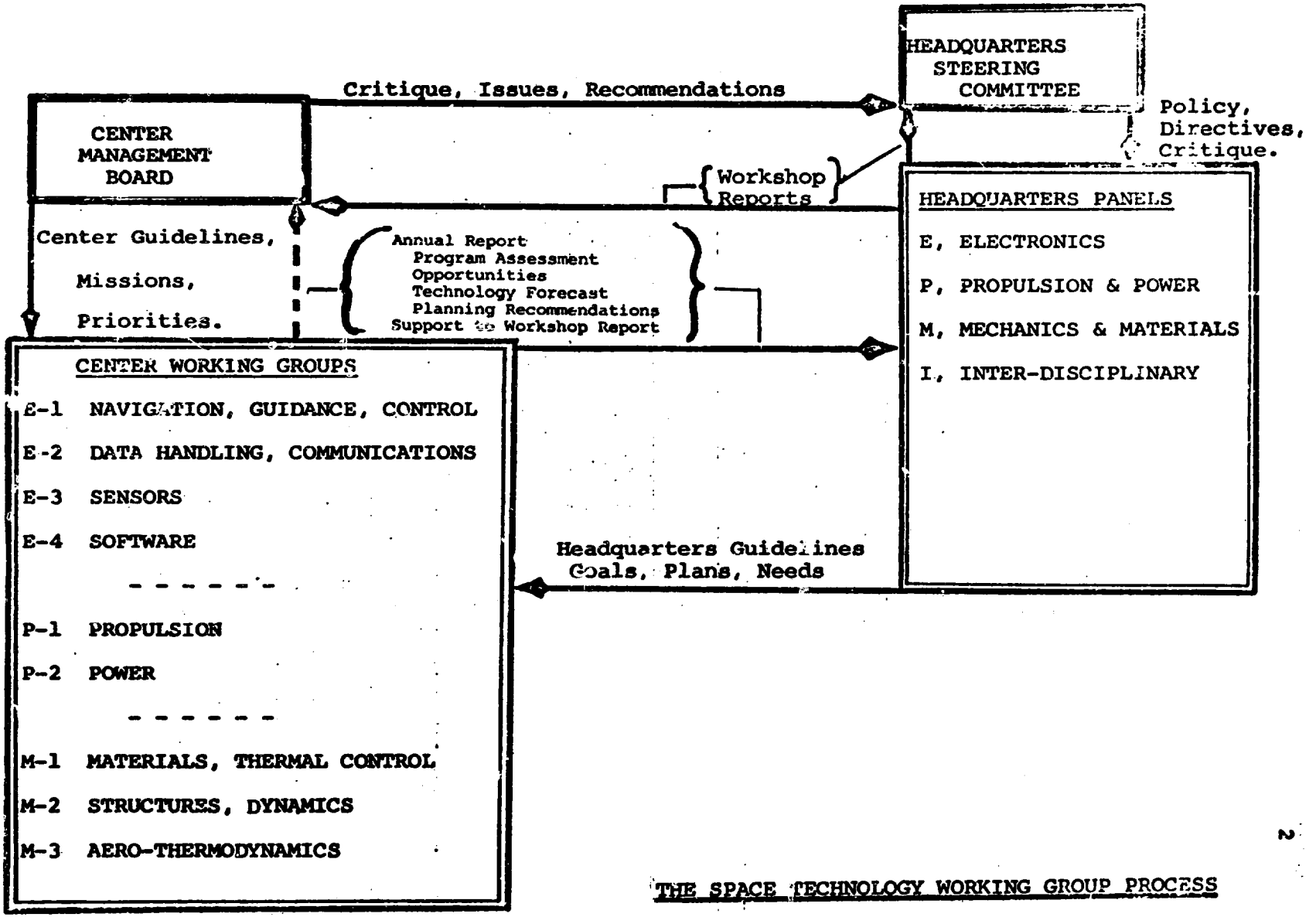
THE WORKING GROUP PROCESS.....

.....FUNCTIONS, OPERATION, AND STAFFING

CENTER WORKING GROUPS, each covering a major technical discipline, constitute the main activity and are therefore central and critical to the success of the process. Each Center Working Group serves as a body of common discipline knowledge and interest representing all of the Agency's operating field centers. The Center Working Groups, meeting or teleconferencing at least quarterly, will maintain an awareness of all relevant activities within the Agency and, to the extent feasible, within the discipline as a whole. They will assess the composite results of ongoing Agency programs and, in an annual report, advise their Headquarters Panel of evaluations and recommendations regarding the quality of the total program and its individual parts. Each group will maintain or have generated, for incorporation in its annual report, an update of the Technology Forecast for its discipline responsibility. This report will also serve to identify voids and unproductive overlap of activities considering efforts internal and external to the Agency. Additionally, the report will recommend to OAST priorities within the Group's discipline. The Center Working Groups will, as requested, provide counsel and support to other Headquarters planning activities.

The Working Groups will meet as a body at an annual Technology Workshop. The annual Working Group reports serve as an input to, and starting point for, the Workshop. The results of this Workshop will be documented in a report for submittal to the Headquarters Steering Committee and the Center Management Board. The Working Groups will support the Headquarters Panels in the preparation of this Workshop document.

Center Working Groups will be staffed with Field Center members from each of those facilities conducting significant R&T in the designated disciplines. DOD members are to be included where appropriate. The Group members are to be recognized leaders in their technical disciplines and knowledgeable representatives



THE SPACE TECHNOLOGY WORKING GROUP PROCESS

of their Center activities. Working Group Chairmen will be Headquarters personnel selected by the Headquarters Panel and will, with the Center Management Board and the Panel, staff their respective groups.

The HEADQUARTERS PANELS will implement the Headquarters Steering Committee policies, directives and other recommendations. They will be responsible for generating, with the assistance of their Working Groups, the Annual Workshop output reports. They will review and evaluate technology plans, including goals, objectives and targets, of all relevant Agency R&T activity and organize joint reviews of technology programs as appropriate. The Panels will meet semi-annually.

The Panels will provide direction to the Center Working Groups. They will evaluate, and respond to insofar as possible, Group recommendations for Headquarters action. The Panels will regulate task assignments to the Groups, and make any required arrangements for interagency, industry or university participation in Working Group activities. With the assistance of the Center Management Board the Panels will ensure that the Center Working Groups are properly staffed, organized and performing their function satisfactorily.

The Interdiscipline Panel will deal with technology at the systems and/or multidiscipline level. It is essential that it work closely with the Center Working Groups, drawing upon the latters' expertise and providing them with needs and requirements. In support of the needs and requirements definition, a major responsibility of the Interdiscipline Panel will be to ensure information flow from the Headquarters Program Offices to the Center Working Groups. As part of this process a Users Workshop will be held one month prior to the annual Technology Workshop. A report of this activity will be submitted to the Working Groups as rapidly as possible, but at least one week prior to the Annual Technology Workshop. Working Groups supporting the Interdiscipline Panel will be established as required.

Panels will consist of representatives from each of the Headquarters Offices sponsoring R&T and will be

chaired by an appropriate OAST Division Director. Panel members must carry the authority of their Offices relative to technology questions, thereby minimizing the number of issues to be referred for resolution.

The CENTER MANAGEMENT BOARD provides, for each Field Center, a focal point for its Working Group activities. Each Board member will provide guidance to his Center's Working Group participants by interpreting Center missions and roles, defining its needs and prioritizing Center technology interests. The Board member coordinates Working Group participation from his Center, insuring support, nominating candidates, and assuring appropriate dissemination of Working Group, Workshop and other reports of value to the Working Group process.

The Board, as a body, attends the Annual Technology Workshop where it receives and evaluates the Headquarters Panel Reports. A board critique is presented to the Steering Committee at the close of the Workshop; separate Board member reports may be submitted to expand on material of special interest or to establish unique Center positions. The Board shall call attention to issues requiring resolution by the Headquarters Steering Committee.

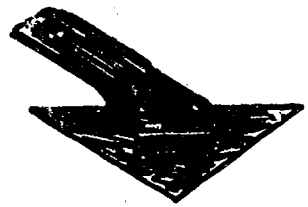
The Board Members, designated by their respective Center Directors, will be at the management levels normally responsible for the planning or execution of technology programs. A rotating Chairman will be selected by the Steering Committee at the Annual Workshop. The Annual Workshop is the only planned meeting of the Board, but informal communication among Board members is expected and encouraged.

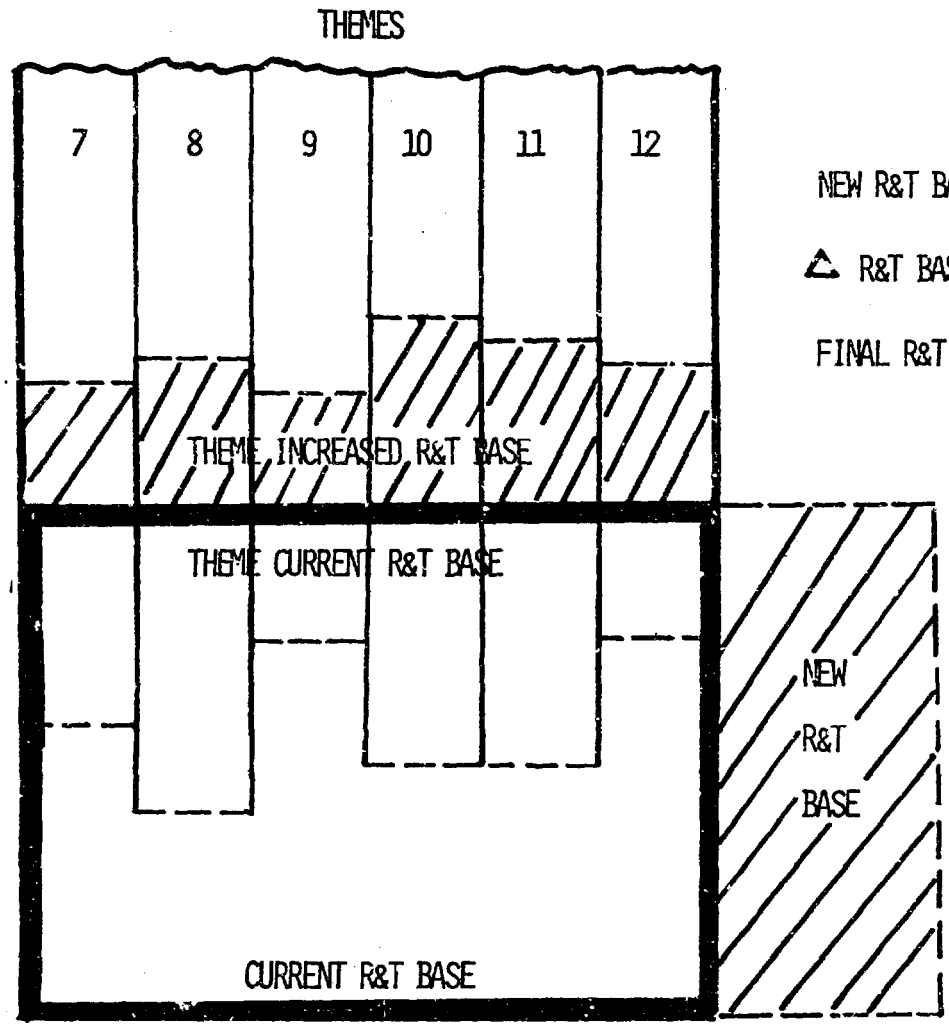
The HEADQUARTERS STEERING COMMITTEE FOR SPACE TECHNOLOGY will be convened annually for the Technology Workshop and further only as required to direct special actions or to resolve issues. The Steering Committee will receive and respond to reports from the Headquarters Panels and the Center Working Groups. The Committee will meet at the close of the Workshop with the Center Management Board, to receive and discuss the Board's critique. Immediately thereafter, the Committee will generate recommendations to the Associate Administrator, OAST, regarding organizational goals, objectives and plans. Issues involving policy interpretation, budget, or

authority constraints will either be resolved or referred appropriately for decision.

The Steering Committee, chaired by the Deputy Associate Administrator, OAST, will be staffed by Headquarters management personnel from all offices sponsoring Space Research and Technology. The OAST, Study, Analysis and Planning Office, Code RX, will ensure the smooth functioning and coordination of the operations aspects of the Working Group systems. It will set objectives, procedures, standards and schedules, and provide necessary support for the annual Workshops. To strengthen the interorganization quality of the Working Group operation, it is proposed that a rotating Center assignee to RX will serve full time as one of this staff.

R & T BASE APPROACH





NEW R&T BASE = THEME CURRENT R&T BASE

△ R&T BASE = (THEME INCREASED + NEW) R&T BASE

FINAL R&T BASE = (CURRENT + △) R&T BASE

WHERE

□ = CURRENT R&T BASE

▨ = △ R&T BASE

□ + ▨ = FINAL R&T BASE

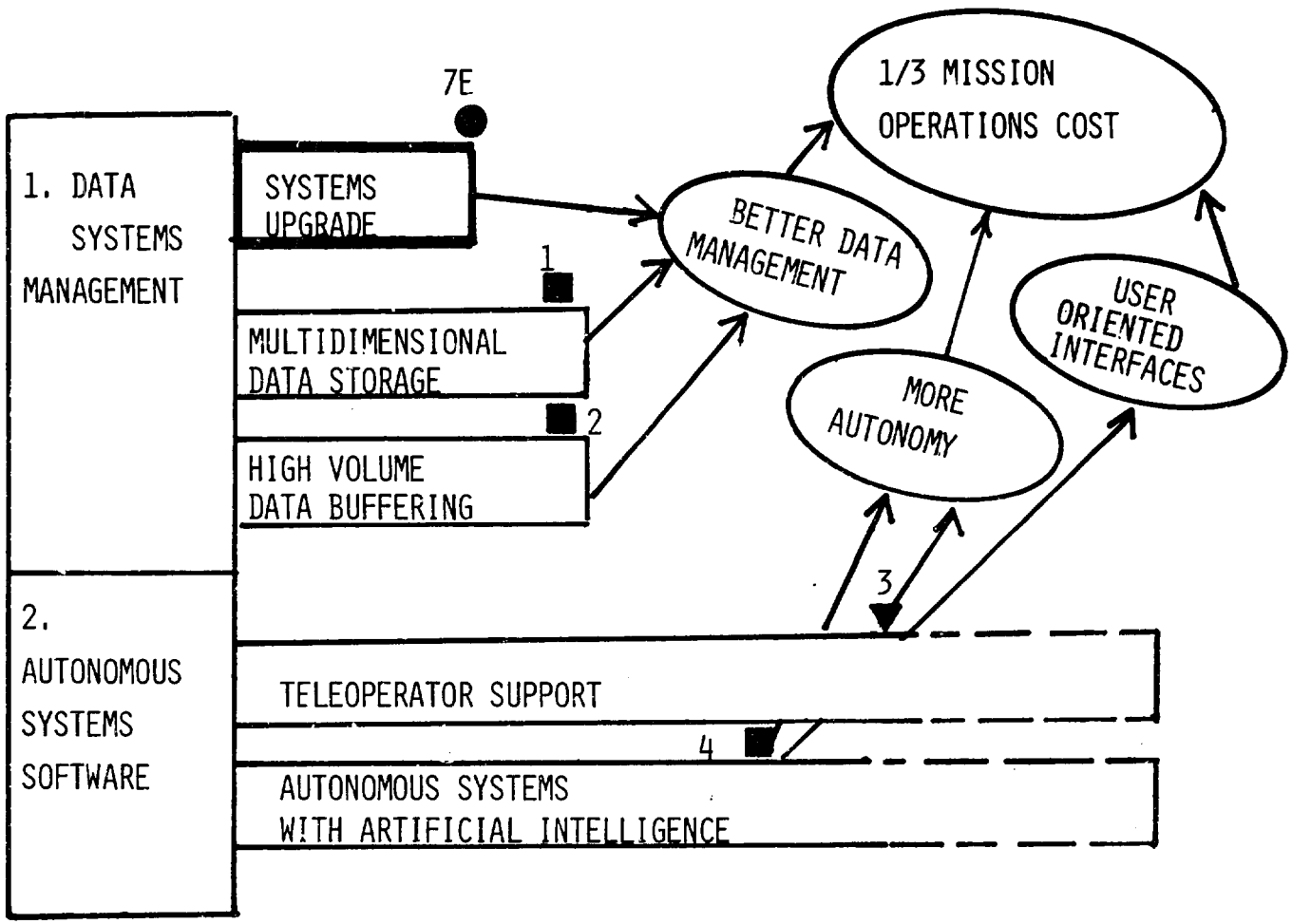
ATTACHMENT 7

R&T BASE

- o EXTENSIVE SUPPORT OF THEMES
  - MANY IN ENABLING CATEGORY — 213 TASKS
  - MOST REPRESENT EXPANSION OR ACCELERATION OF R & T BASE PROGRAMS TO MEET THEME OBJECTIVE — 174 TASKS
  - SOME ARE ON-GOING PROGRAMS CONSIDERED CRITICAL TO THEMES — 39 TASKS
- o LIMITED THEME-INDEPENDENT CANDIDATES — 7 TASKS
- o INDEPTH ASSESSMENT AND PRIORITIZATION OF TOTAL R&T BASE SUBMISSIONS
- o NOT POSSIBLE IN REAL-TIME BUT PLANNED AS WORKSHOP FOLLOW-ON

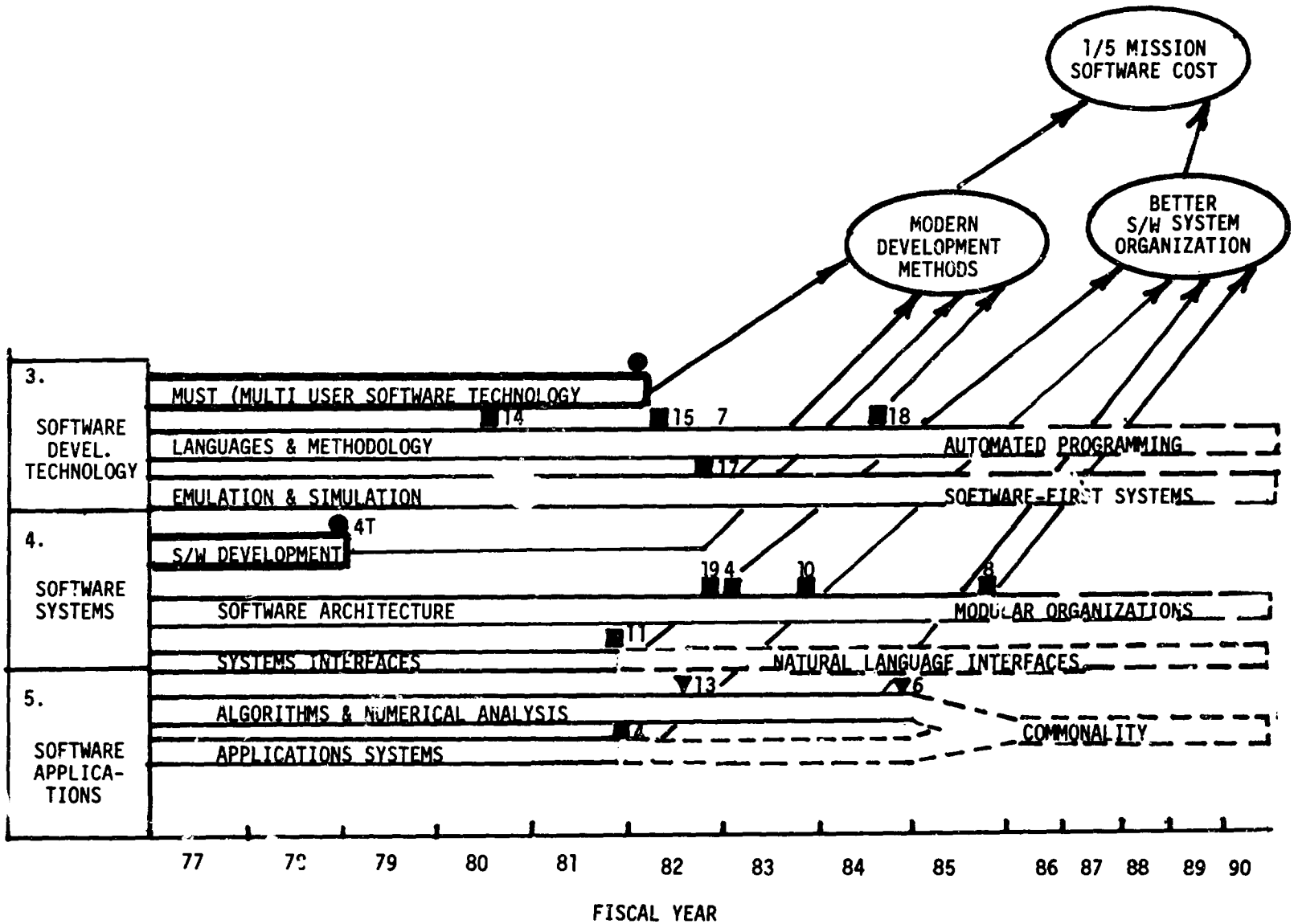
OTHER MATERIAL COVERED IS CONTAINED IN VOLUME IV, R&T BASE.

SOFTWARE (1)



ATTACHMENT-8

SOFTWARE (2)


1/5 MISSION SOFTWARE COST
MODERN DEVELOPMENT METHODS
BETTER S/W SYSTEM ORGANIZATION
3. SOFTWARE DEVEL. TECHNOLOGY
MUST (MULTI USER SOFTWARE TECHNOLOGY
LANGUAGES & METHODOLOGY
AUTOMATED PROGRAMMING
EMULATION & SIMULATION
SOFTWARE-FIRST SYSTEMS
4. SOFTWARE SYSTEMS
S/W DEVELOPMENT
SOFTWARE ARCHITECTURE
MODULAR ORGANIZATIONS
SYSTEMS INTERFACES
NATURAL LANGUAGE INTERFACES
5. SOFTWARE APPLICA-TIONS
ALGORITHMS & NUMERICAL ANALYSIS
COMMONALITY
APPLICATIONS SYSTEMS
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FISCAL YEAR

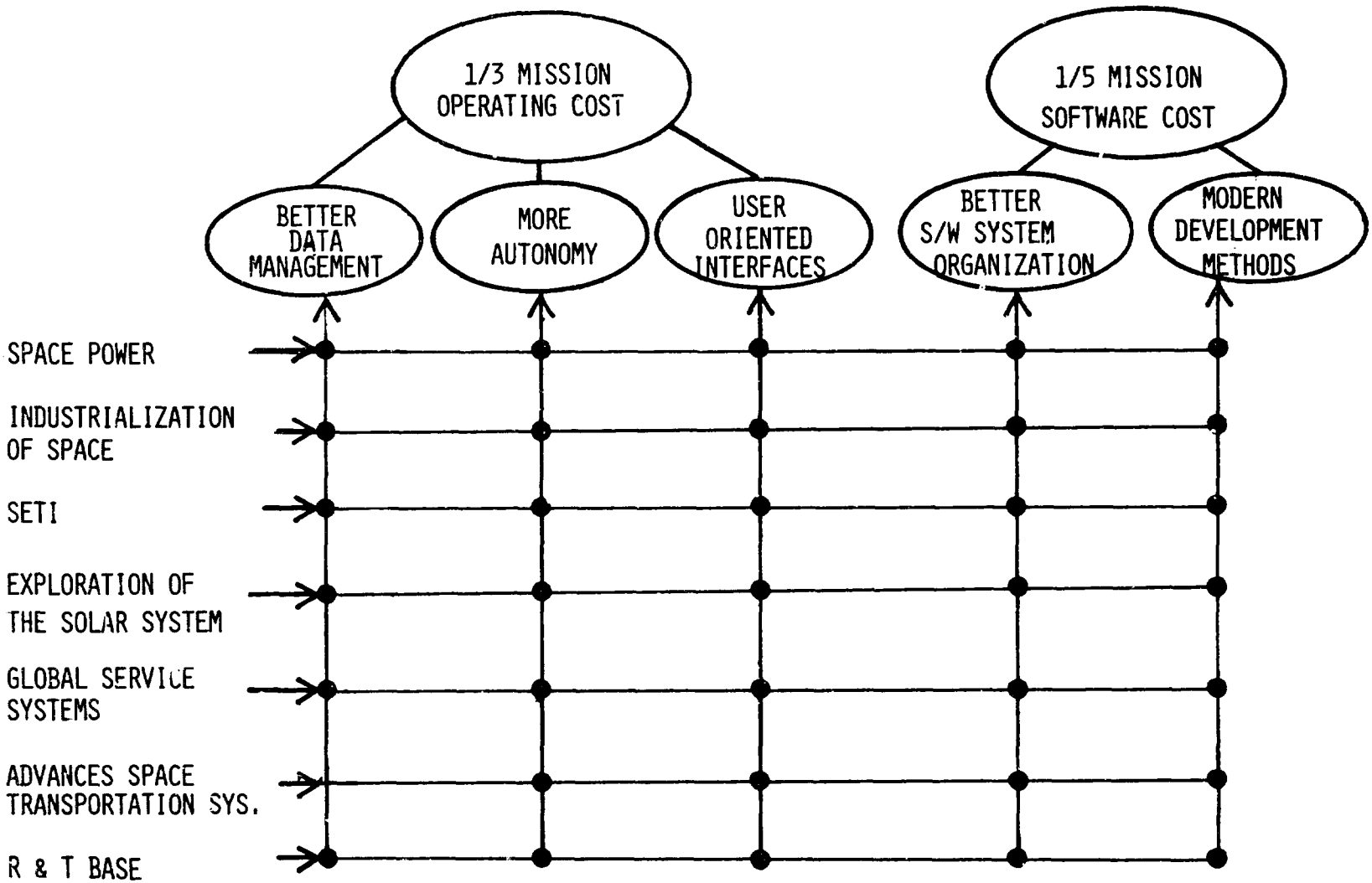
ROADMAP GUIDE

SOFTWARE TECHNOLOGY (E-4)

TECHNICAL AREA	MILE-STONE	TITLE	STATUS/FY	THEME
1. DATA SYSTEMS MANAGEMENT	7E	SYSTEMS UPGRADE	●/80	
	1	MULTIDIMENSIONAL DATA STORAGE	■/81	7-8-9-10-11-1
	2	HIGH-VOLUME DATA BUFFERING	■/81	9-10-11
2. AUTONOMOUS SYSTEMS SOFTWARE	4	AUTONOMOUS SYSTEMS W/ARTIFICIAL INTELL.	■/84	7-8-9-10-11-12
	3	TELEOPERATOR SUPPORT	▼/86	7-8-11-12
3. SOFTWARE DEVELOPMENT TECHNOLOGY	A1	MUST (MULTIUSER SOFT-WARE TECHNOLOGY)	●/82	
	17	SIMULATION TECHNOLOGY	■/82	10-11-12-1
	18	PROGRAMING METHODOLOGY	■/84	9-10-11-12-1
4. SOFTWARE SYSTEMS	4T	SOFTWARE DEVELOPMENT	●/79	
	11	USER-ORIENTED OPERATIONS LANGUAGE	■/82	7-8-10-11-12-1
	8	SYS. SECURITY SOFTWARE	■/86	7-11
5. SOFTWARE APPLICATIONS	4	THEME-UNIQUE APPL. TECH.	■/82	EACH
	6	PATTERN RECOG. ALGORITHMS	■/86	9-10-11-1

E-4 SOFTWARE TECHNOLOGY

THEME SUPPORT



E-4 SOFTWARE

KEY ISSUES

- BROADEN TECHNOLOGY BASE
  - COMMONALITY AND EVOLUTIONARY SOFTWARE
  - SYSTEM INTEGRITY AND AUTONOMY
  - COMMUNICATION AMONG USERS, DEVELOPERS, AND PROGRAMS
- MAKE QUANTUM IMPROVEMENT IN DEVELOPMENT METHODS
  - GO FROM MAGIC TO METHOD
  - USE PEOPLE FOR IDEAS AND MACHINES FOR ROUTINE
- INCREASE AWARENESS OF SOFTWARE CRITICALITY
  - SOFTWARE LIB (EQUAL STATUS)
  - MORE EMPHASIS IN SYSTEM PLANNING
  - OPPORTUNITY FOR ENLIGHTENED MANAGEMENT

MATERIALS & MECHANICS PANEL

WORKING GROUPS

- MATERIALS & THERMAL CONTROL
- STRUCTURES & DYNAMICS
- AEROTHERMODYNAMICS

FINAL REPORT - W.G. M-1

A. IMPACT OF THEME ON DISCIPLINE PLANNING

I. MANY THEME HIGH-PRIORITY MATERIAL NEEDS ARE NOT NOW EMPHASIZED BY RW
- EXAMPLES - MATERIALS FOR ADVANCED PROPULSION, POWER GENERATION AND POWER STORAGE/TRANSMISSION

II THEME INDICATED INCREASE IN NEED FOR THERMAL CONTROL VS. DECLINING LEVEL OF PLANNED SUPPORT IN THIS AREA
- EXAMPLE - THEME 10 CHANGED W.G. PRIORITY FROM 10 TO 2

III NEED FOR CONCENTRATED EFFORT IN CRYOGENIC COOLING SYSTEMS FOR SENSORS WAS SURFACED BY W.G./T.T. INTERACTIONS
- EXAMPLES - T.T.'s 9, 10 & 11

FINAL REPORT – W.G. M-1

A. IMPACT OF THEME ..... (CONT'D)

IV. THEME TEAMS INDICATED SPECIFIC PROGRAM VOIDS

- EXAMPLE – NEED FOR LIGHT-WEIGHT NUCLEAR SHIELDING MATERIALS

V LITTLE COMMONALITY BETWEEN NEEDS OF VARIOUS THEMES IN DISCIPLINE PROGRAMS

- EXAMPLE – THERMAL CONTROL NEEDS

VI THEMES TEND TO SUPPORT NEAR-TERM DEVELOPMENT RATHER THAN EXPLORATORY: PROBLEM FOR R&T ACCEPTANCE?

- EXAMPLE – THEME II LOWERED PRIORITY FOR CONDUCTIVE COATINGS – JEOPARDIZED FUNDING

FINAL REPORT - W.G. M-1

B. COMMENTS ON THEME & NEW INITIATIVES

I - OF TOTAL THEME NEEDS IDENTIFIED, NUMBER OF 70% REQUIRE NEW INITIATIVES
— about 3/4 of needs require folding/development of new initiatives

II - NEW INITIATIVES SUBMITTED BEFORE THEME DEVELOPMENT APPLY TO LESS THAN 10% OF NUMBER OF THEME NEEDS (Tasks)
(New initiatives now existing cover only 10% of Theme needs)

III NUMBER OF NEWER INITIATIVES REQUIRED TO SUPPORT TOTAL THEME NEEDS IS 60% We need to increase the new initiatives by 60% for next.

M-1 MATERIALS & THERMAL CONTROL

THEME 7 - MULTIPURPOSE SPACE POWER PLATFORM

TECHNOLOGY NEEDS

INCREASED PROGRAM -

- POWER GENERATION MATERIALS/PROCESSES
- POWER STORAGE AND TRANSMISSION MAT'LS/PROCESSES
- COMPOSITES FOR LARGE SPACE STRUCTURES

NEW INITIATIVES -

- #309 SPACE DEGRADATION OF COMPOSITE MAT'LS
- IN-SITU SPACE MFG. OF LARGE STRUCTURES
- LONG-TERM SPACE EFFECTS ON MATERIALS

M-1 MATERIALS & THERMAL CONTROL

THEME 8 - INDUSTRIALIZATION OF SPACE

TECHNOLOGY NEEDS -

NEW INITIATIVES -

- #111 THERMAL SYSTEM DESIGN
- #123 SPACELAB COMBUSTION EXP. FACILITY
- DEVELOPMENT OF FABRICATION TECHNIQUES FOR SPACE ERECTABLE STRUCTURES
- EFFECT OF SPACE ENVIRONMENT ON MATERIALS
- EXTRACTION OF STRUCTURAL MATERIALS FROM LUNAR SURFACE MAT'LS

M-1 MATERIALS & THERMAL CONTROL

THEME 9 - SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI)

TECHNOLOGY NEEDS

INCREASED PROGRAM

- LONG-LIFE CRYOGENIC SYSTEMS FOR MASERS, ETC.

KEY INITIATIVES -

- #111 THERMAL SYSTEM DESIGN
- STABLE MATERIALS FOR LARGE ANTENNA STRUCTURES
- LARGE-AREA THIN-FILM STRUCTURES FOR RFI PROTECTION

M-1 MATERIALS & THERMAL CONTROL

THEME 10: EXPLORATION OF THE SOLAR SYSTEM

TECHNOLOGY NEEDS

INCREASED XGRAM

- CRYOGENICS FOR SCIENCE
- CRYOGENICS FOR MASERS
- MATERIALS FOR POWER CONVERSION

NEW INITIATIVES

- NUCLEAR SHIELDING MATERIALS
- ELECTRONIC MATERIALS FABRICATION
- SOLAR SAIL MATERIALS

M-1 MATERIALS & THERMAL CONTROL

THEME II: GLOBAL SERVICE SYSTEMS

TECHNOLOGY NEEDS

INCREASED PROGRAM -

- CONDUCTIVE THERMAL CONTROL COATINGS

NEW INITIATIVES -

- # 309 SPACE DEGRADATION OF COMPOSITES
- CRYO SYSTEMS FOR SENSORS
- MANUFACTURING IN SPACE
- ULTRA-HIGH CONDUCTIVITY HEAT PIPES
- DIMENSIONALLY STABLE STRUCTURAL MATLS
- CONTAMINATION

M-1 MATERIALS & THERMAL CONTROL

THEME 12: ADVANCED SPACE TRANSPORTATION

TECHNOLOGY NEEDS

INCREASED PROGRAM

- THERMAL CONTROL SYSTEMS & MATERIALS

NEW INITIATIVES

- #131 ORBITER EXPERIMENTS (OEX)
- #309 SPACE DEGRADATION OF COMPOSITES
- #123 SPACELAB COMBUSTION EXP. FACILITY
- MATERIALS FOR ADVANCED PROPULSION
- NDT/NDE FOR STRUCTURES

M-2 STRUCTURES/DYNAMICS

SUMMARY COMMENTS ON THEME IMPACT

TWO MAJOR THRUSTS IN STRUCTURES TECHNOLOGY

1) LARGE SPACE STRUCTURES (THEMES 7,8,9,10,11)

CREATIVE EFFORTS REQUIRED TO ACHIEVE BREAKTHROUGHS FOR VERY LARGE ACCURATE STRUCTURES

2) ADVANCED TRANSPORTATION (THEME 12)

REQUIRES RENEWED EMPHASIS ON THERMAL STRUCTURES TECHNOLOGY

M-2 Structures/Dynamics

Large Space Structures (7, 8, 9, 10, 11)	W.G. Priorities
Space Deployable	1
Space Assembled	2
Oribital Module Assembly	5
Long Life Habitable Structures	6
Space Manufactured Structures	7
Deployable Laser Mirror	12
Seti Antenna & Shield	13
Solar Sail Structure	15

M-2 STRUCTURES/DYNAMICS

PRIORITIZED NEEDS

ADVANCED SPACE TRANSPORTATION SYSTEMS (12)	W.G. PRIORITIES
• ADV. HIGH TEMPERATURE REUSABLE STRUCT.	3
• RECOVERY AND LANDING TECHNOLOGY	4
• IN-SERVICE NDE TECHNIQUES	8
• PAYLOAD DYNAMICS AND ACOUSTICS	9
• L/V LOADS ANALYSIS OPTIMIZATION	10
• DAMAGE TOLERANCE	11

M-3 AEROTHERMODYNAMICS

THEME # 10 EXPLORATION OF THE SOLAR SYSTEM

SPACECRAFT

- ATMOSPHERIC PROBES
- SURFACE PENETRATORS
- SAMPLE RETURN VEHICLES
- SURFACE LANDERS

TECHNOLOGY NEEDS (IN PRIORITY)

- HEATING AND FLOW FIELD DEFINITION
- STABLE CONFIGURATIONAL AERODYNAMICS FOR PROBES
- PENETRATOR CAPABILITY
- PLUME - PLANETARY SURFACE INTERACTION
- EFFICIENT LANDER CONFIGURATION

NEW INITIATIVES

- SHUTTLE-LAUNCHED EXPERIMENTAL RE-ENTRY SYSTEM

M-3 AEROTHERMODYNAMICS

THEME #12 ADVANCED SPACE TRANSPORTATION

SPACECRAFT

- ADVANCED VEHICLE
- HEAVY LIFT VEHICLE
- ORBITAL TRANSFER VEHICLE

TECHNOLOGY NEEDS (IN PRIORITY)

- ESTABLISH AEROTHERMAL DESIGN CRITERIA
- PERFORM FLIGHT VERIFICATION TESTS
- OPTIMIZE CONFIGURATIONAL CHARACTERISTICS
- DETERMINE TPS WALL SURFACE EFFECTS

NEW INITIATIVES RECOMMENDED

- #108 SHUTTLE WINDWARD HEATING EXPERIMENT
- #113A SHUTTLE LEESIDE HEATING EXPERIMENT
- #113E SHUTTLE AIR DATA SYSTEM
- DEVELOPMENT OF THE TECHNOLOGY BASE FOR ADV. STS

M-3 AEROTHERMODYNAMICS

THEME #1 R & T BASE

TECHNOLOGY NEEDS (IN PRIORITY)

- INCREASE COMPUTATIONAL FLUID DYNAMICS CAPABILITY
- DEVELOP ENERGY CONSERVATIVE FACILITIES
- CONDUCT RESEARCH IN MULTI-ENGINE BASE FLOW

NEW INITIATIVES RECOMMENDED

- #202 OPTIMIZED FLUID DYNAMICS PROCESSOR

MULTIPURPOSE SPACE POWER PLATFORM #7

AND

INDUSTRIALIZATION OF SPACE #8

1983 100-200KW LEO

CRITICAL TECHNOLOGY	FY 78 PROGRAM AUGMENTATION	FY 78 NEW START
o OASIS		X
o SPHINX B/C		X
o SOLAR ARRAY TECH. FOR SEP & P/L APPL.	X	
o LARGE NI-CD BATTERY		X
o MICROWAVE TRANSMISSION	X	
o MULTI-KILOWATT DISTRIBUTION SYSTEM		
o HI POWER/HI VOLTAGE/LOW LOSS COMPONENTS	X	
o ADVANCED ELECTRONIC PWR. COND. TECH.	X	
o HEAT PIPES FOR HIGH THERMAL DENSITIES	X	
o REMOTE POWER CONTROLLER TECHNOLOGY	X	
ΔFUNDING REQUIRED	2615K	6600K

POWER REQUIREMENTS - MSPP(#7)

LAUNCH DATE	1983	1988	2000+
• ORBIT LOCATION	LEO	GSO(P), LEO (S)	GSO
• POWER - KW	100(P) 200(S)	1,000	10,000
• VOLTS - DC	120	120	440
• LOADS	OFF-THE-SHELF HARDWARE	20 KV LASER PROPULSION; INDUSTRIAL	LASER PROP; HABITAT; M'F'G
• LIFE - YRS.	5	10	30
• AUTONOMOUS	YES	YES	YES
• MAINTENANCE	BY MAN	BY MAN	BY MAN
• PROPULSION	STATION KEEPING	SAME	• SAME • POSSIBLE ORBIT TRANSFER

(P) PRIMARY

(S) SECONDARY

MULTIPURPOSE SPACE POWER PLATFORM #7

AND

INDUSTRIALIZATION OF SPACE #8

1988 IMW GSO

Critical Technology	FY 78 Program Augmentation	FY 78 New Start
o Oasis		X
o Lightweight, Radiation Resist. Solar Array	X	
o Sphinx B/C		X
o Laser Power Converter/Transmission		
o Photovoltaic/Electrolysis/Fuel Cell Tech.		X
o Lightweight, Low Cost Silicon Arrays		
o Auto. Power Systems Management (APSM)	X	
o High Power, High Voltage, Low Loss Components	X	
o Auto. Test Techniques & Technology	X	
o Multi-Kilowatt Distribution System		
o Heat Pipes for High Thermal Densities	X	
o Advanced Electronic P.C. Technology	X	
o Tech. for Improving Perf. & Life: Alk. Battery	____	____
ΔFUNDING REQUIRED	1865K	4500K

POWER REQUIREMENTS - INDUSTRIALIZATION OF SPACE (#8)

LAUNCH DATE	1983	1988	2000
o POWER - KW	10s	10^3	TO 10^5
o VOLTS - DC	120	120	100 TO 440
o LOADS	-	-	1000 OUTLETS
o ORBIT	LEO	LEO, GSO	LEO, GSO, LUNAR BASE (100 MEN)
o LIFE-YRS	5-10	10-15	25-30
o AUTONOMOUS	YES	YES	YES
o MAINTENANCE	YES	YES	YES
o PROPULSION	STATIONKEEPING	SAME	SAME

POWER REQUIREMENTS - SETI (No. 9)

LAUNCH DATE	1984	1990	2000
• POWER - KW	2	3-PLUS PROPULSION	10
• VOLTS	?	?	?
• SPECIAL LOADS	-	ORDER OF MEGAWATT FOR SHIELD AND DISH PROPULSION	-
• ORBIT	LEO/GSO	GSO/LUNAR DISTANCE	GSO/LUNAR DISTANCE
• UNIQUE ENVIRONMENT	o S/C CHARGING o HALF TIME SHADOW	SAME SAME	SAME SAME
• LIFE - YEARS	10	10	30
• AUTONOMOUS	YES	YES	YES
• MAINTENANCE	YES	YES	YES
• PROPULSION; ORBIT TRANSFER AND POSITIONING	YES	YES	YES
• SPECIAL EMI;RFI;ETC.	YES	YES	YES

SETI #9

Critical Technology	FY 78 Program Augmentation	FY 78 New Start
o Environment Charging of Surfaces	X	
o Lightweight, Radiation-Resistant Solar Arrays	X	
o Photovoltaic Electrolysis Fuel-Cell Technology		X
o Advanced Regenerative Hydrogen, Oxygen Fuel Cell		X
o Advanced Electronic Power Conditioning Technology	X	
o Lightweight, Low-Cost Silicon-Cell Arrays		
o Silicon-Solar-Cell Technology		
o Oasis		X
o Automati. Power-Systems Management	X	
o Remote Power-Controller Technology	X	
o Sphinx B/C		X
o Nuclear Thermionic Space Power System	X	
o Tech. for Improving Performance and Life: Alk. Battery	———	———
ΔFUNDING REQUIRED	3990K	4720K

POWER REQUIREMENTS - EXPLORATION FACILITY (#10)

LAUNCH DATE	1990	1995
• ORBIT LOCATION	EARTH	OUTER PLANET
• POWER - KW [PROP + SCIENCE]	200	500
• VOLTS	≤200, 1000	SAME
• REGULATION [SCIENCE]	1%	SAME
• LIFE - YRS	≤10	20
• AUTONOMOUS	YES	YES
• MAINTENANCE	MAN	RESUPPLY, SAMPLE-RETURN
• PROPULSION [ORBITER]	SEP OR NEP	NEP
• ENVIRONMENTS		
- RADIATION	LEO TO GEO, NEP	NEP, JUPITER
- OTHER PLANETARY		-150°K, HIGH G
		IMPACT, RFI
• FACILITY SUPPORT	FREE FLYER	FREE FLYERS (RTG)
		PROBES (RTG, BATT'Y)
		LANDERS (RTG, BATT'Y)
		SAMPLE-RETURN (RTG, BATT'Y)

*YEAR 2000 STUDY FACILITY UNDEFINED

EXPLORATION OF SOLAR SYSTEM #10

Critical Technology	FY 78 Program Augmentation	FY 78 New Start
o Nuclear Thermionic Space Power Module	X	
o Autonomous Power Systems Management	X	
o Advanced Planetary Power System Tech.		X
o Planetary Power Processing		
o Automated Test Techniques	X	
o Long-Life Light-Weight Ni-Cd Batteries		
o Probe Battery Technology		
o Battery Technology		
o Thermoelectrics		
o Solar Array for SEP	X	
o Light-Weight Array		
o Silicon Solar Cell Technology		
ΔFUNDING REQUIRED	3700K	1000K

CONCERN

- Solar Exploration Theme
  - Emphasizes exploration facility, starting 1990
  - Abrupt jump in technology is required
  - Not preceded by evolutionary growth program in 1980's
  - 1980 exploration program undefined

POWER REQUIREMENTS - GLOBAL SYSTEMS (#11)

LAUNCH DATE	1983	1988	2000
• POWER - KW (ORBIT)	20 (LEO)	50 (LEO) 20 (GSO)	500 (LEO) 20 (GSO)
• VOLTS - DC	120, HIGHER FOR SENSORS	SAME	SAME
• STORAGE FOR ECLIPSES	YES	YES	YES
• UNIQUE ENVIRONMENT	-	SPACECRAFT CHARGING	YES
• LIFE - YEARS	3 - 5	3 - 5 LEO 5 - 10 GSO	10 LEO 20 GSO
• AUTONOMOUS	NO	PARTIAL	TOTAL
• MAINTENANCE	ONCE/YEAR	ONCE/YEAR	ONCE IN 3 YEARS
• PROPULSION	STATION KEEPING -	SAME ORBIT TRANSFER?	SAME SAME
• EMI, RFI	QUIET PREFERRED	SAME	SAME

GLOBAL SERVICE #11

CRITICAL TECHNOLOGY	FY 78 PROGRAM AUGMENTATION	FY 78 NEW START
o SOLAR ARRAY TECHNOLOGY FOR SEP & P/L APPLICATION	X	
o LONG LIFE, LIGHT WEIGHT NI-CD BATTERY		
o ADVANCED ELECTRONIC P.C. TECHNOLOGY	X	
o MULTIKILOWATT DISTRIBUTION SYSTEM		
o TECHNOLOGY FOR IMPROVING PERFORMANCE & LIFE (ALK. BATTERY)		
o REMOTE POWER CONTROLLER TECHNOLOGY	X	
o SILICON SOLAR CELL TECHNOLOGY		
o LIGHT WEIGHT, LOW COST SILICON CELL ARRAY		
o LIGHT WEIGHT, RADIATION RESIST. SOLAR ARRAY	X	
o LARGE NI-CD BATTERY		X
o SILVER-HYDROGEN RECHARGEABLE BATTERY	X	
o POWER TRANSFER ACROSS ROTORY JOINTS		X
o INTEGRALLY REGULATED SOLAR ARRAY TECH.	X	
o ENVIRONMENTAL CHARGING OF SURFACES	X	
ΔFUNDING REQUIRED	2900K	650K

ADVANCED SPACE TRANSPORTATION SYSTEM #12

CRITICAL TECHNOLOGY	FY 78 PROGRAM AUGMENTATION	FY 78 NEW START
o LIGHTWEIGHT FUEL CELL		
o INTEGRALLY REGULATED SOLAR ARRAY	X	
o HI POWER/HI VOLTAGE/LOW LOSS COMPONENTS	X	
o REMOTE POWER CONTROLLER TECHNOLOGY	X	
o HI PERFORMANCE THERMIONIC CONVERSION TECHNOLOGY	X	
o ADVANCED ELECTRONIC POWER CONDIT. TECHNOLOGY	X	
o LONG LIFE, LIGHTWEIGHT NI-CD BATTERY		
o SOLAR ARRAY TECHNOLOGY FOR SEP AND PAYLOAD APPL.	X	
ΔFUNDING REQUIRED	2950K	

PROPULSION TECHNOLOGY WORKING GROUP FINDINGS

OAST SPACE TECHNOLOGY WORKSHOP

APRIL 30, 1976

LANGLEY RESEARCH CENTER

HAMPTON, VIRGINIA

ATTACHMENT-1

PROPULSION TECHNOLOGY WORKING GROUP

APPROACH

(1) EXAMINED VEHICLE MATRIX FROM THEME 12

(2) DETERMINE TRANSPORTATION NEEDS OF OTHER SPACE THEMES AGAINST THEME 12 REQUIREMENTS

(3) IDENTIFIED TWO ADDITIONAL PROPULSION FUNCTIONS

(4) IDENTIFIED TOTAL PROPULSION NEEDS AGAINST REVISED MATRIX

(5) PRIORITIZED & EVALUATED ALL PROPULSION "NEEDS" FOR EACH VEHICLE

(6) PROVIDED DOCUMENTATION (Rx FORMS)

PROPULSION NEED REQUIREMENTS FOR THEME SUPPORT

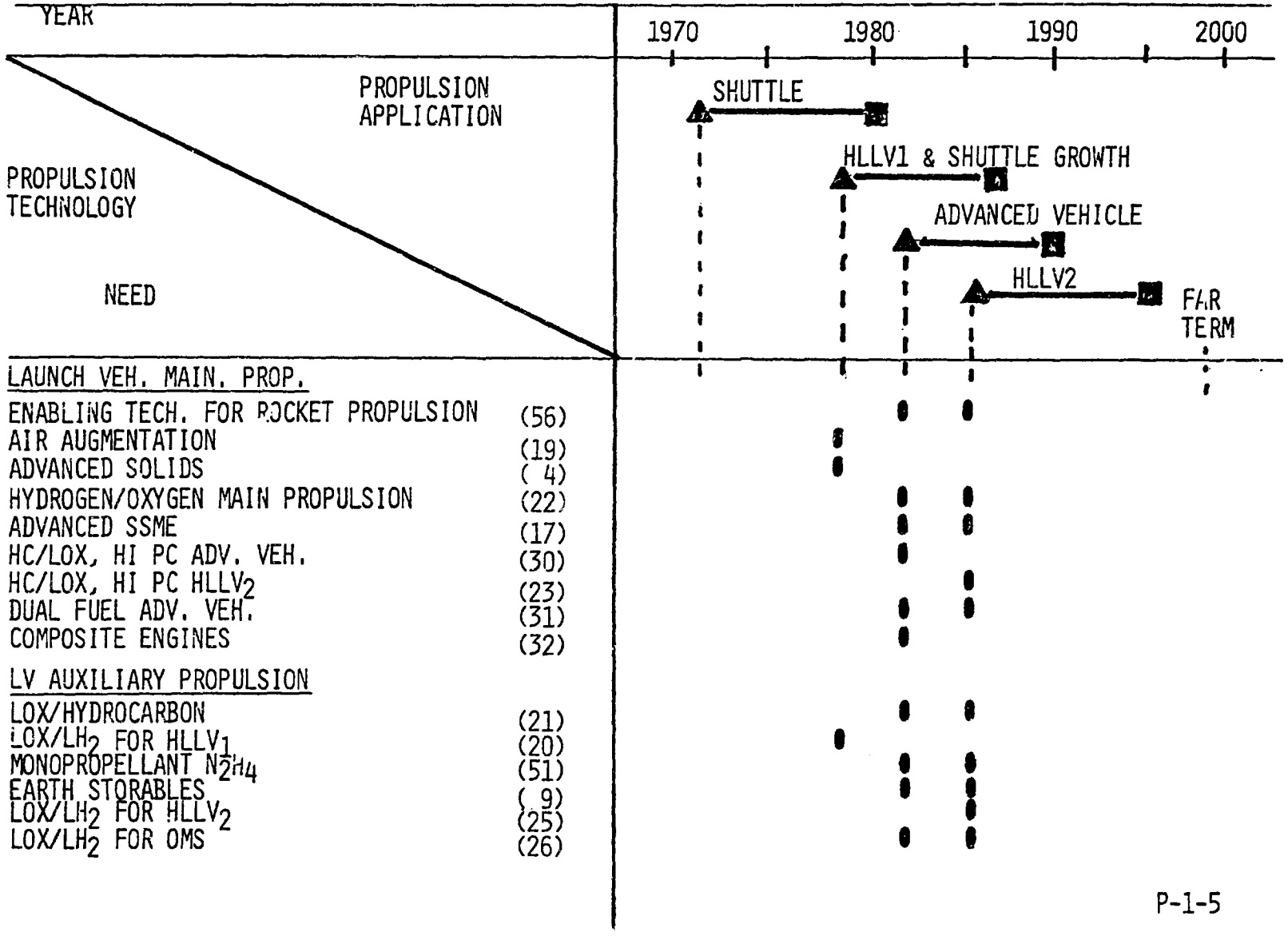
SPACE THEMES / VEHICLE CLASSES	S.P. 7	I 8	SETI 9	SOLAR SYS. 10	G. SER. 11	ATS 12
(P) OTV	●	●	●			●
(C) OTV	●	●	●	●	●	●
$HLLV_1$ (1985)		●	●	●		●
$HLLV_2$ (1995)		●	●			●
ADV. VEH.	●	●	●		●	●
PLANETARY				●		
ON-ORBIT STAB.	●	●	●	●	●	

PROPULSION TECHNOLOGY WORKING GROUP

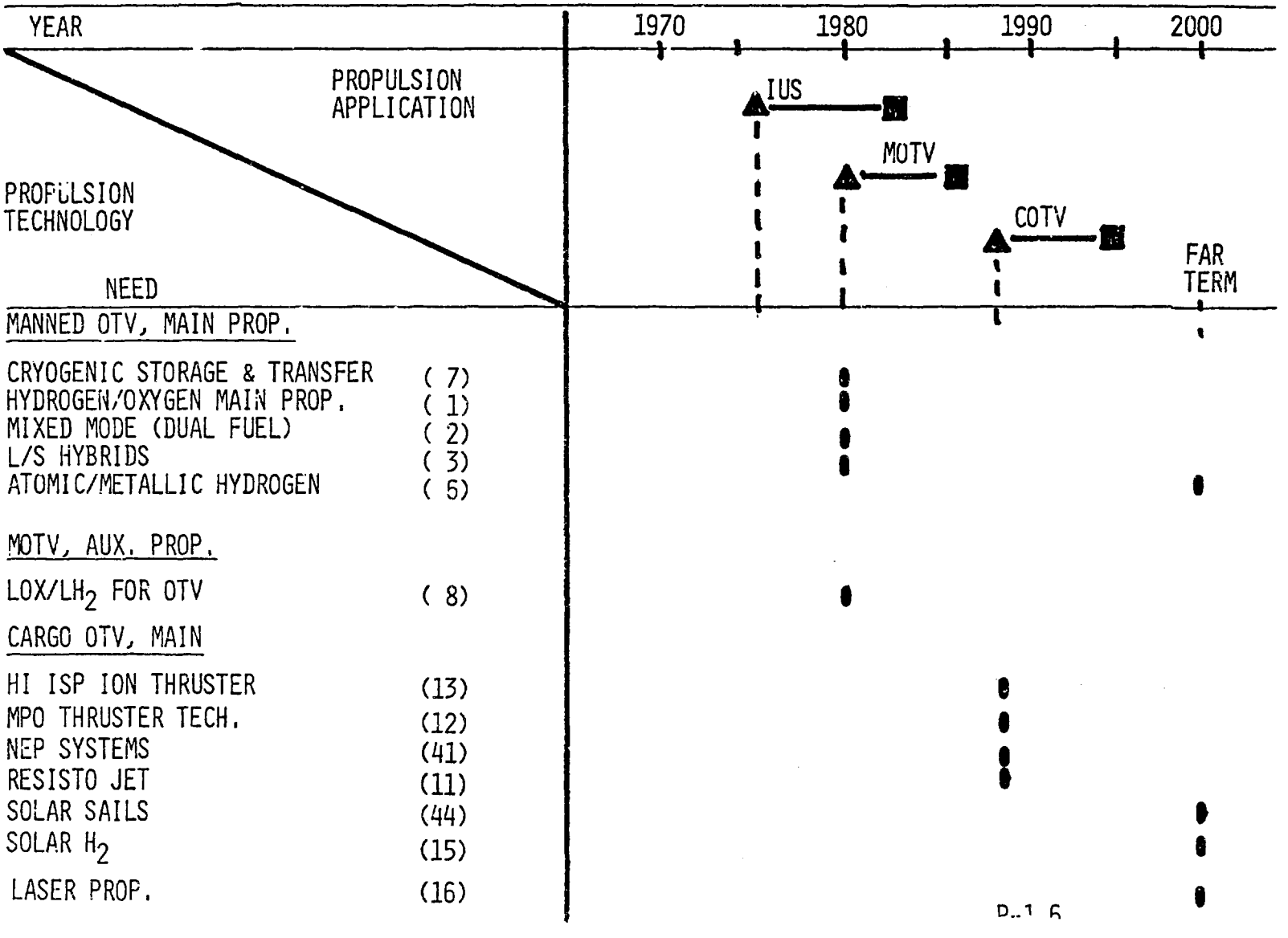
PROPULSION NEED RATING CRITERIA

- USE DATE
- CRITICALITY
  - ENABLING
  - ENHANCING
    - HIGH
    - MEDIUM
    - LOW
- PROBABILITY OF MEETING TECHNOLOGY GOAL

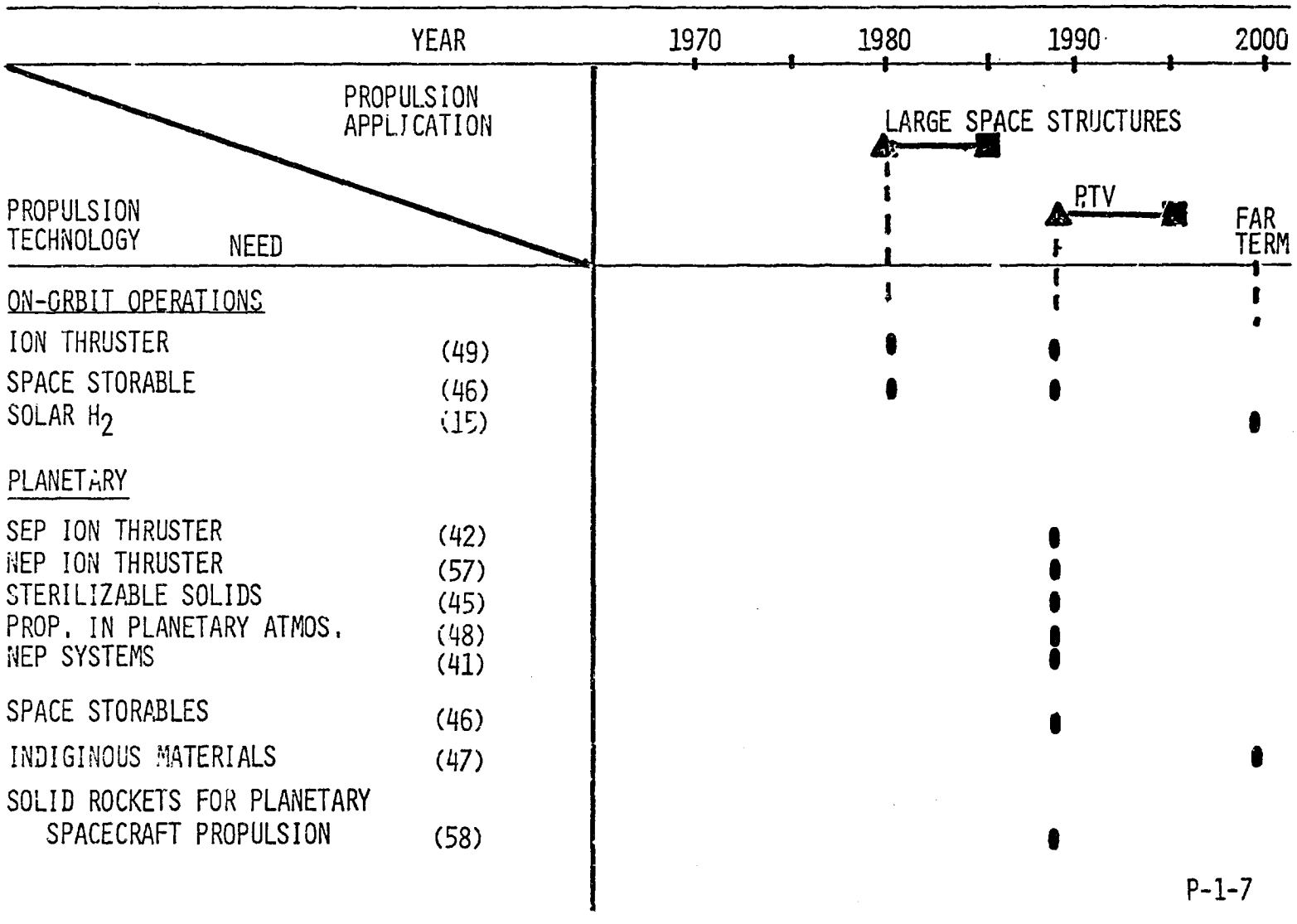
PROPULSION WORKING GROUP SUMMARY



PROPULSION WORKING GROUP SUMMARY



PROPULSION WORKING GROUP SUMMARY



PROPULSION TECHNOLOGY WORKING GROUP

CONCLUSIONS

- THEME 12 UNDERLYING TO ALL OTHERS
- ENABLING PROPULSION TECHNOLOGY AREA KEY TO REDUCED TRANSPORTATION COSTS AND INCREASED SPACE CAPABILITY
- FURTHER OAST EVALUATION OF ALL PROPULSION NEEDS NECESSARY TO ESTABLISH RESOURCE REQUIREMENTS

WORKSHOP OBSERVATIONS

- o THEMES PROVED EXTREMELY STIMULATING
- o WORKSHOP SHARPENED THEME TECHNOLOGY REQUIREMENTS
- o HIGH LEVEL OF INTEREST & SUPPORT OF THEME PROCESS
- o MANY ON-THE-SPOT CREATIVE CONCEPTS AND APPROACHES
- o IDENTIFIED UNANTICIPATED PROBLEMS AND POSSIBLE SOLUTIONS
- o EXCELLENT TRANSFER OF THEME AND TECHNOLOGY UNDERSTANDING
- o OUTSTANDING COMPETENCE AND DEDICATION
- o GOOD INTERPERSONAL INTERACTIONS
- o LITTLE CENTER PAROCHIALISM
- o NEAR-TERM NEEDS NOT IN THEMES (IDENTIFIED BY WG'S)
- o OUT-OF-SCOPE PROBLEMS - PREDICTIVE MODELING
  OPERATIONAL SYSTEMS
  LUNAR MATERIALS PROCESSING
  COMPREHENSIVE SENSOR R & T PROGRAM

THEME 7 MULTIPURPOSE SPACE POWER PLATFORM

WORKSHOP RESULTS

- EFFECT OF SPACECRAFT CHARGING, HIGH VOLTAGES, AND SPACE PLASMAS, BIG UNKNOWN
- MUCH COMMONALITY WITH TECHNOLOGY NEEDED FOR SPS
- USE OF TRANSMITTED POWER FOR PROPULSION
  BIG POWER REQUIREMENT, BIG PAY-OFF
- DEFINITION OF PACING TECHNOLOGIES IN POWER, PROPULSION, G & C, STRUCTURES AND DYNAMICS, MATERIALS
- BENEFITS DEMONSTRATED TO OTHER THEMES

TECHNOLOGY FOR INDUSTRIALIZATION OF SPACE #8

KEY FINDINGS

- IDENTIFIED & PRIORITIZED 5 NEW INITIATIVES
  - TWO EXISTING
  - THREE NEW
  - TWO INITIATIVES TO BE DEVELOPED IN TANDEM
- CRITICAL PROBLEM
  - LARGE NUMBER OF SMALL TASKS DIFFICULT TO ASSEMBLE INTO THEME-ORIENTED INITIATIVES
- CURRENT R & T BASE INADEQUATE

SETI - THEME 9

KEY WORKSHOP FINDINGS

- BROAD PROGRAM NEW INITIATIVE REFINED INTO SPECIFIC TECHNOLOGY INITIATIVES
- CENTER MANAGEMENT PLAN AND CENTER ROLES DEFINED
- GOOD COMMUNICATION OF THEME REQUIREMENTS WITH WORKING GROUPS
- IDENTIFIED LARGE ANTENNA FIGURE CONTROL AS THE MOST CHALLENGING TECHNICAL PROBLEM
- DISCOVERED TECHNOLOGY PROGRAMS VALUABLE FOR SETI (E.G. MASS MEMORIES)
- REFINED SETI REQUIREMENTS (E.G. SPACECRAFT CHARGING) AND SETI MILESTONES
- PRODUCTIVE PEOPLE INTERACTIONS
- OPPORTUNITY TO EXPLAIN OBJECTIVES, RATIONALE AND APPROVAL OF SETI PROGRAM

EXPLORATION OF THE SOLAR SYSTEM

KEY FINDINGS

- Broad base of technical competence available for key technology concerns
  - Autonomy, artificial intelligence, robotics
  - Long life
  - End to end data management
  - Pre-nuclear reactor technology
- Software technology holds great promise in many areas, e.g.,
  - Mission planning and scheduling
  - Autonomy
  - Simulation
- Many imaginative and exciting sensors and instruments proposed; OAST must study our proper role
- Close coordination between OAST theme and agency thrust activities required - Concern is to maintain orderly evolution of technology - avoid step functions

THEME #11 - GLOBAL SERVICE SYSTEMS

KEY FINDINGS

- MISSION SCENARIO: TWO-STAGE APPROACH REASONABLE
- THEME CREDIBILITY: GOOD COUPLING BETWEEN TECHNOLOGY DEVELOPMENT AND NASA PROGRAM THRUSTS
- TECHNOLOGY: EMPHASIS ON DATA SYSTEMS, SOFTWARE, SENSOR TECHNOLOGY, GUIDANCE AND CONTROL, POWER, LARGE STRUCTURES, THERMAL CONTROL

  CRITICAL AREAS IN DATA SYSTEMS AND SOFTWARE

  STATUS - NO INSOLUBLE PROBLEMS BUT... TECHNOLOGY IS CORNUCOPIA, E.G., WE NEED TRADE-OFF BETWEEN COST AND CAPABILITY.

- CRITICAL ISSUES:
  - THEME AREA HIGHLY DEPENDENT ON PREDICTIVE MODELING THEORY, NOT PRESENTLY OAST ACTIVITY
  - MISSION DEFINITION NEEDS MORE EFFORT
  - NEED BETTER APPRECIATION/COUPLING WITH REAL USERS

THEME 12 - TECHNOLOGY FOR ADVANCED SPACE TRANSPORTATION SYSTEMS (ASTS)

- DETAILED QUESTIONS BY DISCIPLINE WORKING GROUPS CAUSED RE-EXAMINATION OF MISSION/SYSTEMS REQUIREMENTS, I.E., ELECTRICAL vs CHEMICAL PROPULSION (POWER/PROPULSION RELATIONSHIPS)
- IMPLEMENTATION OF MPPS COULD PROVIDE PROPULSION/POWER FOR SOME OTV SYSTEMS.
- SOFTWARE OFFERS POTENTIAL FOR AUTOMATED CHECKOUT AND REDUCED OPERATIONS (RECURRENT) COSTS.
- COMPLETE CONCURRENCE WITH POWER STRUCTURES WORKING GROUPS (MAKES US NERVOUS).
- PROPULSION TREATED AS A MULTI-DISCIPLINE TECHNOLOGY, I.E., FOUR FIRST PRIORITIES, ETC.
- USUALLY DIFFICULT TO PRIORITIZE ITEMS BELOW FOURTH RANK.
- ASTS OPERATIONS REMAINS FERTILE FIELD FOR ADVANCED TECHNOLOGY - RECOMMEND OPERATIONS WORKING GROUP.
- SOLID PROPULSION AND NEP MUST NOT FALL IN CRACKS BETWEEN THEMES.
- SYSTEM ENGINEERING STUDIES NOT IDENTIFIED BY WORKING GROUPS - MUST BE ADVANCED.
-"THEME TEAM" APPROACH HAS PROVIDED AN EFFECTIVE FOCUS FOR TECHNOLOGY DEVELOPMENT WHICH HAS BEEN REFLECTED IN THE WORKING GROUP PLANNING.